Journal of
Physics, Astrophysics and Physical Cosmology
Volume 2, Issue 1, 2010

The Casimir Force Along the Universal Boundary: Quantitative Solutions and Implications

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Abstract

To accommodate an intrinsic universal pressure of about 0.1 nPa the Casimir solution requires a second boundary separated from the universal perimeter by 54 μm. The estimated power density (0.45 W/m^2) from the associated blackbody electromagnetic emissions from this concentric shell along the universal boundary would be within the mJy range at earth distance. We found that the convergence between the reciprocal values for electromagnetic wavelength associated with the time required for any increment of space to increase by one Planck length also converged at 54 μm. The two quantitative solutions would be compatible with an intrinsic resonance within the organization of spatial dimensions and would require a reciprocal representation within the smallest and largest spaces.

Introduction: The Casimir Effect at the Universal Boundary

According to Bordag et al. (2001), the Casimir effect is a quantum manifestation involving the infinite vacuum energy of the quantized electromagnetic field in free Minkowski space (Petkov, 2007). The simplest form is the interaction of a pair of neutral, parallel conducting planes due to the disturbance of the vacuum of the electromagnetic field. We examined the quantitative implications of assuming that the boundary of the universe is two closely adjacent concentric shells whose large estimated circumference (between 10^{26} to 10^{27} m) partially satisfies the condition of two neutral, parallel conducting plates.

Casimir's equation for the finite force (F) acting between two parallel neutral plates is:

$$F(a)= -[(\pi^2/240)(\hbar c/a^4)]\ S, \qquad (1)$$

where a is the separation between the plates, S, the area is >> a^2, $\hbar$ is the modified Planck constant and c is the speed of light. Emphasizing pressure is revealing because it isolates the quantized value for a. To obtain a in this instance we assumed the intrinsic "pressure" within the universe was about 15.0 x 10^{-11} Pa (Persinger, 2009). The potential validity of the value was based upon its utility for an estimate of the mass of the universe (10^{52} kg) that was convergent with solutions from other approaches (Kolombet, 1995), including empirical inferences (Lauroesch, 1998). From this perspective the negative value of the Casimir effect could reflect an opposing force around the universal perimeter.

The equation for a, the separation between the two neural boundaries, would be:

$$a=[-(\pi^2\hbar c)S/(240F)]^{1/4} \qquad (2)$$

and the resulting value for this separation would be 54 μm.

The Convergence of Spatial Expansion and Electromagnetic Wavelength

If the universe is expanding, then the units of matter and space would be expected to expand in a systematic manner. We (Persinger and Koren, 2007) have reasoned that the smallest discrete increment of expansion would be one Planck length (1.6 x 10^{-35} m). If an average of 75 km/s per Mparsec (3.1 x 10^{22} m) is assumed for Hubble's constant, the reference value for expansion is 2.4 x 10^{-18} s^{-1}. The velocity of expansion for a width of space would be its product with this

value. For example, if the length of a proton is assumed to be twice the Compton radius or wavelength (2.6×10^{-15} m), the velocity would be 8.3×10^{-33} m/s. The time to expand one Planck length would be 1.6×10^{-35} m divided by 8.3×10^{-33} m/s or about 3 msec.

The upper and lower boundaries of this relationship contain a paradox. For the smallest length of space (one Planck), the time required to expand one Planck length is about 3×10^{17} s or the estimated age of the universe. For the largest length of space, the width of the universe (assuming 1.9×10^{26} m) the time would be about 3.5×10^{-44} s, which is the same order of magnitude and approaching the coefficient for one Planck time (5.3×10^{-44} s). A more complete table for intermediate values has been published elsewhere (Persinger and Koren, 2007). The relevance of this potential contradiction occurs when the relationship between the associated frequency and the electromagnetic wavelength is compared with the Casimir solution.

If we assumed that frequency is the inverse of the time required for any unit of space to increase by one Planck length, then the electromagnetic wavelength (assuming c is the velocity of light) can be calculated. This inverse relationship between the length of space considered for expansion and the associated EM wavelength results in a discrete value of convergence. This is the point where the increasing length of space begins to become larger than the associated wavelength and visa versa. This value, as shown in Figure 1, is also 54 μm.

Quantitative Convergence

With a Casimir solution of 54 μm for the separation between the two concentric surfaces of the universal boundary and assuming this thin shell is functionally a black body, the equivalent temperature according to Wein's law would be 53 K. From Stephan's law, the power density would be the product of T^4 and 5.67×10^{-8} W/m^2 or 0.45 W/m^2. This energy density would be equally distributed within and around the entire shell and directed inward within the universal volume.

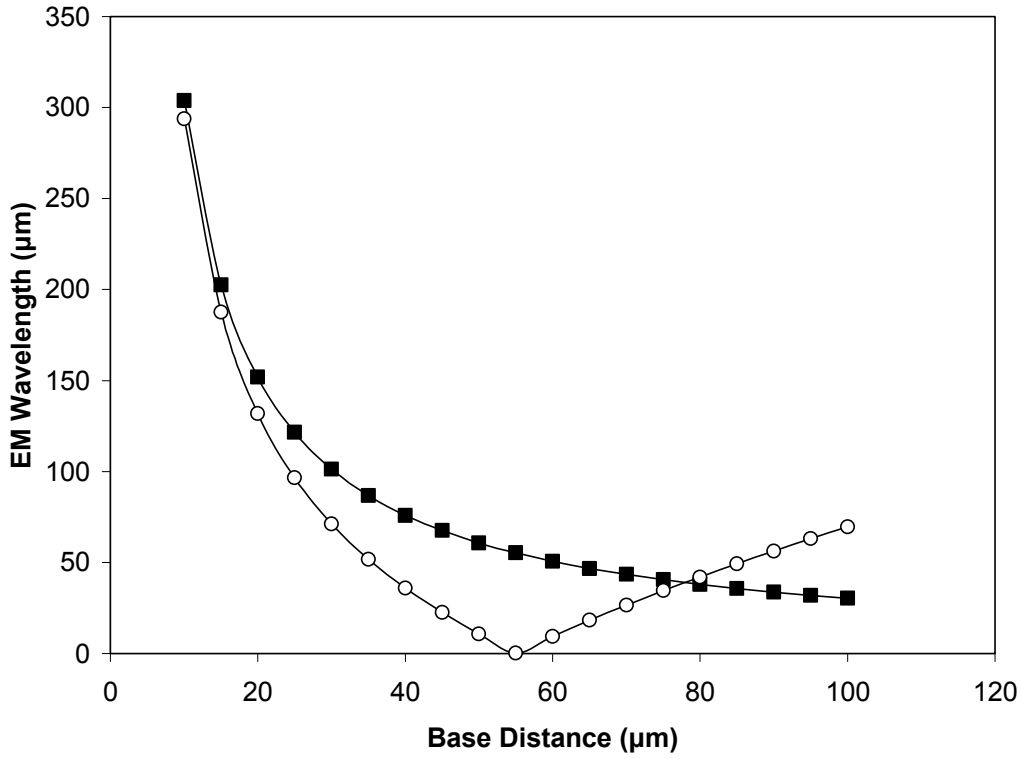

Figure 1. Calculated electromagnetic (EM) wavelength in micrometers (μm) as a function of the associated EM wavelength from the expansion of one Planck length (dark squares) and the absolute difference between the EM wavelength and the base length (open circles) from which it was derived.

Varshni (1976) reported that the distribution of red- and blue-shift data at the time of his publication suggested our solar system is near the center of the distribution of galaxies and by inference the universe. With this assumption, the energy generated by and throughout the black body shell produced by this Casimir effect would decrease as a function of r^{-1} in all directions. Consequently the power density reaching radio telescopes would be .45 W/m^2/9.5 x 10^{25} m or about .47 Jy (1 Jansky=10^{-26} W/m^2 Hz) or 470 mJy. This value is within the range of background levels measured for the most distant galaxies and unidentified bodies (Barger, et al., 1998) with large (z > 1) red shifts.

If the Casimir pressure is multiplied by the volume rather than the area of the assumed value of the universe, the net energy would be the product of 1.1 x 10^{78} m^3 and 1.5 x 10^{-10} Pa or 10^{68} J. This value is within 10% of the total energy equivalent (about 2 x 10^{69} J) of the universe with an assumed mass of 10^{52} kg (Persinger, 2009). This energy equivalence is commensurate with the solution for a modified field equation of $(8\pi G/c^4)$ T_{uv}, where T represents matter and energy. Because T is a larger value, the net direction would be expansion rather than contraction.

Predictions and Implications

If the Casimir solution of 54 μm is associated with an electromagnetic equivalent along the perimeter of the universe, then we predict a peak in energy within this band. From the above estimates it should be at least a factor of 10 greater than the typical background and concentrated within a band between 53μ and 55 μm. "Redshifts" in the range between 30 μm and 300 μm wavelengths are only possible from space platforms because of the opacity of the atmosphere. Even the technical restraints such as the discrete energies of the photons, angular resolution due to diffraction of photons in the telescope's primary mirror, and the intrinsic difficulty of detecting infrared compared to optical photons, affect the limen. However, the 54 μm enhancement should be evident and should constitute a "homogeneous" background.

The first implication is that the convergence of electromagnetic wavelength and spatial expansion of one Planck length around a discrete point might reflect one mode of resonance frequency within the organization of space. It might be considered analogous to the resonance frequency that emerges at the intersection of the positively accelerating reactive impedance curve and the negatively accelerating reactive capacitance curve in an electronic circuit. This would mean that 5.55 THz would be continuously emitted at energies in the order of 10 times greater than frequencies adjacent to this resonance.

The electromagnetic frequency of 5.55 THz is associated with an energy (hf) of 3.7 x 10^{-21} J or 22 mV (J/q). The mass equivalent for this energy as a photon is 4.1 x 10^{-41} g. Tu et al. (2005) have shown that the upper bounds of the dispersion of the velocity of light ($\Delta c/c$) in different ranges of the electromagnetic spectrum has corresponding limits on photon mass. For the value 4.1 x 10^{-41} g the accompanying wavelength would be between 0.35 μm and 0.55 μm. An example source would be the Crab Nebular pulsar.

The second implication involves the formation of matter. As indicated by Puthoff (1989) gravity is an induced effect associated with changes in the quantum-fluctuation energy of the vacuum when matter is present. Hence, gravity is more analogous to Casimir forces. One of the vacuum quantum effects associated with an intrinsic frequency of the vacuum zero-point-fluctuation is the creation of particles from the vacuum by external fields. If the boundary conditions depend upon time (they are changing), the transfer of external energy to virtual particles (the vacuum oscillations) transforms them to "real" or measurable ones (Bordag et al., 2001).

Given the universal boundary is expanding the conditions for transforming "virtual particles" to matter would be satisfied. This would suggest that the mass of the universe would increase (Persinger, 2009). The presence of 0.45 W/m^2 over a universal surface area of 4.5 x 10^{53} m^2 would result in the availability of 2.0 x 10^{53} J/s with a mass equivalence of 2 x 10^{36} kg or about 1 million solar masses per sec. At this rate, the time required to produce the mass of the universe (10^{52} kg) would be in the order of 10^{16} s, which is within a factor of 10 of the estimated age of the universe even without accommodating rates of change in expansion.

The third implication is the solution to the intrinsic contradiction that the smallest space requires the age of the universe to expand one Planck length while the universe jumps one Planck length within one Planck time. Both extremes are boundary conditions in that they exceed Nyquist limits. In order for any process to be discerned, at least two successive

increments of time are required (Persinger, 1999). At the maximum limit of space, the entire universe, where the largest increment of space approaches the largest increment of time to observe change and at the minimum limit of space, one Planck length, where the smallest increment of space approaches the smallest increment of time, there is no process.

Effectively these two conditions are quantitatively indistinguishable but may have philosophical significance. This apparent contradiction can be accommodated if the smallest space (one Planck length) and the largest space (the universal boundary) are mutually mapped on to each other. In this specific condition the product of the times for all the Planck length units (which individually require the age of the universe to expand one Planck length) would be one Planck time, which was the solution for the entire set (the universe). A mathematical description would most likely involve Hilbert space with a discrete solution (Prozen, 1994).

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